CLAIMS

What is claimed is:

1. A method of induction heat treatment, comprising the steps of:

(1) selecting an article for heat treatment comprising a hub having a hub surface and a plurality of angularly spaced trunnions extending from a corresponding plurality of trunnion shoulders formed in the hub surface, each trunnion shoulder having a trunnion shoulder surface, and each trunnion having a trunnion axis and a trunnion surface;

(2) selecting an induction coil, which is adapted to receive a trunnion for heat treatment and apply a magnetic field to the trunnion surface and trunnion shoulder surface;

(3) placing a trunnion within the induction coil with its corresponding trunnion shoulder adjacent to the induction coil;

(4) rotating the trunnion within the induction coil about the trunnion axis at a selected speed;

(5) energizing the induction coil to apply the magnetic field and produce induction currents within the trunnion shoulder surface and trunnion surface of the article for a time sufficient to induce heating them to a heat treatment temperature (T_H) to at least a selected case depth;

(6) withdrawing the trunnion from the induction coil at a selected rate;

(7) cooling the trunnion surface and the trunnion shoulder surface of the article to a temperature (T_C) to the selected case depth; and

(8) repeating steps (3)-(7) for a selected number of the trunnions.

2. The method of claim 1, wherein the article comprises a spider.

3. The method of claim 2, wherein the spider has a barrel-shaped outer surface, a plurality of angularly spaced cylindrical shoulders extending from the outer surface, and a plurality of cylindrical trunnions extending from the cylindrical shoulders.

4. The method of claim 2, wherein the spider comprises a pearlitic/ferritic steel.

5. The method of claim 4, wherein the steel comprises AISI 1050 steel.

6. The method of claim 4, wherein T_H is greater than the austenite transition temperature.

7. The method of claim 6, wherein the T_H is in the range of 1700 - 2000°F.

8. The method of claim 6, wherein said step of cooling comprises quenching the trunnion.

9. The method of claim 8, wherein T_C is less than the martensite start temperature and greater than the martensite finish temperature.

10. The method of claim 9, further comprising stopping the quenching when the trunnion surface and the trunnion shoulder surface of the spider is less than or equal to T_C to the selected case depth, and then permitting the trunnion surface to cool under ambient conditions.

11. The method of claim 10, further comprising the step of (9) shielding any previously heated trunnion surface and trunnion shoulder surface during step (7) from additional quenching, wherein all of the trunnion surfaces are cooled from T_C under ambient conditions.

12. A method of induction heat treatment of a spider having a barrel-shaped outer surface, a plurality of cylindrical trunnion shoulders formed in the outer surface of the hub and a corresponding plurality of angularly spaced cylindrical trunnions extending from the shoulders, each trunnion shoulder having a trunnion shoulder surface, and each trunnion having a trunnion axis and a trunnion surface, comprising the steps of:

(1) selecting an induction coil, which is adapted to receive a trunnion for heat treatment and apply a magnetic field to the trunnion surface and the trunnion shoulder surface;

(2) placing a trunnion within the induction coil with its corresponding trunnion shoulder adjacent to the induction coil;

(3) rotating the trunnion within the induction coil about the trunnion axis at a selected speed;

(4) energizing the induction coil to apply the magnetic field and produce induction currents within the trunnion shoulder surface and trunnion surface of the article for a time sufficient to induce heating them to a heat treatment temperature (T_H) to at least a selected case depth;

(5) withdrawing the trunnion from the induction coil at a selected rate;

(6) cooling the trunnion surface and the trunnion shoulder surface of the article to a temperature (T_C) to the selected case depth; and

(7) repeating steps (2)-(6) for a selected number of the trunnions.

13. The method of claim 12, wherein the spider comprises a pearlitic/ferritic steel.

14. The method of claim 13, wherein the steel comprises AISI 1050 steel.

15. The method of claim 13, wherein T_H is greater than the austenite transition temperature.

16. The method of claim 15, wherein T_H is in the range of 1700 - 2000°F.

17. The method of claim 15, wherein said step of cooling comprises quenching the article.

18. The method of claim 17, wherein said step of cooling comprises quenching until T_C is lower than the martensite start temperature.

19. The method of claim 18, wherein T_C is less than the martensite start temperature and greater than the martensite finish temperature.

20. The method of claim 19, further comprising stopping the quenching when the temperature of the trunnion surface and the trunnion shoulder surface reaches T_C to the selected case depth, and then permitting the spider to cool under ambient conditions.

21. The method of claim 20, further comprising the step of (8) shielding any previously heated trunnion surface during step (6) from additional quenching, wherein all of the trunnion surfaces and trunnion shoulder surfaces are cooled under ambient conditions.

22. An article, comprising:

a steel spider comprising a hub, a plurality of angularly spaced trunnion shoulders extending from the hub, each having a trunnion shoulder surface, and a corresponding plurality of angularly spaced trunnions extending from the plurality of trunnion shoulders, each trunnion having a trunnion axis and a trunnion surface, the trunnion surfaces and the trunnion shoulder surfaces comprising a hardened case, wherein the hardened case is formed by an induction heat treatment.

23. The article of claim 22, wherein the induction heat treatment comprises the steps of (1) selecting an induction coil, which is adapted to receive a trunnion for heat treatment and apply a magnetic field to the trunnion surface and the trunnion shoulder surface; (2) placing a trunnion within the induction coil with its corresponding trunnion shoulder adjacent to the induction coil; (3) rotating the trunnion within the induction coil about the trunnion axis at a selected speed; (4) energizing the induction coil to apply the magnetic field and produce induction currents within the trunnion surface and trunnion shoulder surface of the article for a time sufficient to induce heating them to a heat treatment temperature (T_H) to at least a selected case depth; (5) withdrawing the trunnion from the induction coil at a selected rate; (6) cooling the trunnion surface and the trunnion shoulder surface of the article to a temperature (T_C) to the selected case depth; and (7) repeating steps (2)-(6) for a selected number of the trunnions.

24. The article of claim 23, wherein the induction hardened case comprises a martensitic microstructure and the core comprises a microstructure that is a mixture of pearlite and ferrite.

25. The article of claim 24, wherein the induction hardened case has a hardness of about R_C 58-63, and the core has a hardness of about R_C 15-30.

26. The article of claim 24, wherein the martensitic microstructure is a tempered martensitic microstructure.

27. The article of claim 26, wherein the tempered martensitic microstructure is formed by the induction heat treatment.

28. The article of claim 27, wherein the tempered martensitic microstructure has a hardness of about R_C 58-63.

29. The article of claim 28, wherein the depth of the case is about 1 – 2 mm.